TA705.3C69G46 1983

GEOTECHNICAL INVESTIGATION FOR FLOOD CONTROL MEASURES ON COYOTE CREEK

Prepared for

Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, California 95118

Submitted by

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June 1983 - D207P

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GEOLOGY
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GEOHYDROLOGY

June 16, 1983
D207P

Mr. George Korbay,
Flood Control Manager
Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, California 95118

Subject: Technical Proposal for Consultant Study, Geotechnical Investigation for Flood Control Measures on Coyote Creek Between Highway 237 and San Francisco Bay

Dear Mr. Korbay:

Earth Sciences Associates (ESA) is pleased to submit this technical proposal for the proposed geotechnical investigation for flood control measures on Coyote Creek. This document presents a preliminary work program based on review of geotechnical reports and data in the District's and our files, and on a field reconnaissance along the full length of the proposed levees.

We have a good understanding of the existing site conditions and of the geotechnical considerations associated with the proposed project, and look forward to discussing this project with you during our presentation on June 22, 1983.

Very truly yours,

EARTH SCIENCES ASSOCIATES, Inc.

Julio E. Valera
Vice President

JEV:km

Enclosures

GEOTECHNICAL INVESTIGATION FOR FLOOD CONTROL MEASURES ON COYOTE CREEK

Table of Contents

Page

I. INTRODUCTION 1

II. PROJECT UNDERSTANDING 3

- A. Geology 3
- B. Reach I 4
- C. Reach II 6
- D. Seismic Design Considerations 9

III. TECHNICAL APPROACH 11

- A. Phase I - Review Available Data 11
- B. Phase II - Field Investigation, Laboratory Testing Program, and Preliminary Analyses 12
- C. Phase III - Finalize Analyses and Report Preparation 15

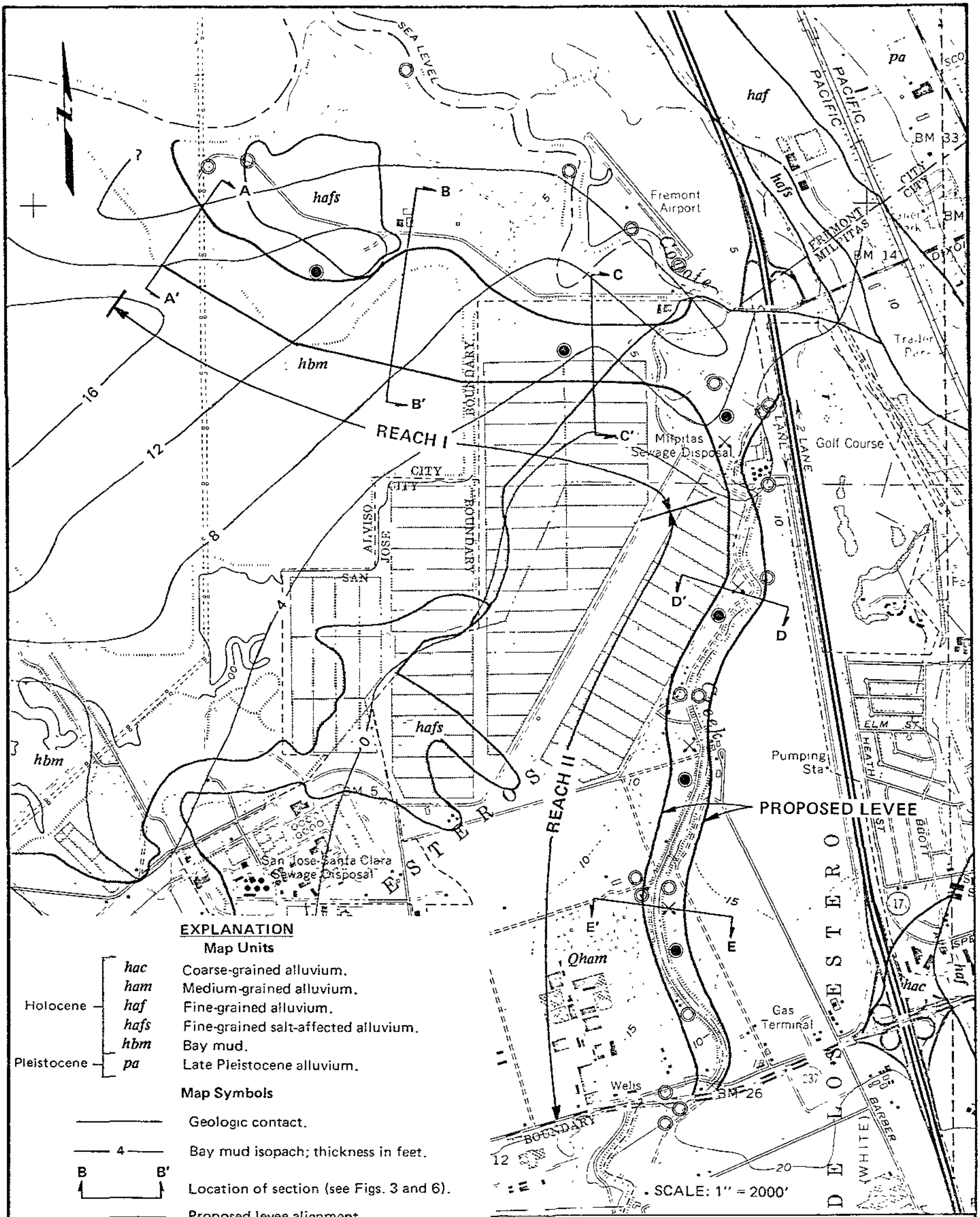
IV. PROJECT MANAGEMENT AND SCHEDULE 18

I. INTRODUCTION

Severe flooding of the north San Jose area including the community of Alviso occurred twice within an 11-month period during 1982-1983. These floods originated from the lower reaches of Coyote Creek at two separate locations: in 1982 by overtopping and eroding through the levee at seven points east of Agnews State Hospital; in 1983 by levee overtoppings north of Highway 237. The storm of February 28 through March 4, 1983 caused more than $20 million in damage, thousands of people had to be evacuated, Highways 237 and 17 were closed, and the San Jose/Santa Clara Sewage Treatment Plant came within inches of being flooded.

Flooding in the north Santa Clara County lowlands is not a new problem (historic records indicate the Eighth California Mission was destroyed by flooding of the Guadalupe River in 1784), but has been aggravated by 20th century development of the area. Subsidence, caused by overdraft of groundwater, has lowered the ground surface to below sea level in some areas and disrupted drainage. The existing levees along Coyote Creek were largely built by farmers to avoid flooding of their adjacent lands, and periodically raised as subsidence continued. These levees were not engineered to withstand extremely high water. When subsidence, poorly constructed levees, unfavorable rainfall and bay tide pattern combined to cause watershed flows more than 3 times greater than the carrying capacity of some reaches of Coyote Creek, flooding was inevitable.

Engineering solutions to the flooding problem on Lower Coyote Creek exist and have been studied by both the Santa Clara Valley Water District and the U.S. Army Corps of Engineers. The Lower Coyote Creek Project is to be constructed on the land between San Francisco Bay to the north and Highway 237 to the south and between Highway 17 to the east and the sewage treatment ponds to the west (see Figure 1). The Water District's study considered several alternatives including modifying the floodplain, constructing bypass channels, trapezoidal channel excavations, one bank widenings and levee construction. The plan with minimum right of way requirements and smallest environmental impacts and construction costs was found to be a combination of one bank widening and construction of levees. The geotechnical aspects of that project are the focus of this technical proposal.



EXPLANATION

Map Units

Holocene	*hac*	Coarse-grained alluvium.
	ham	Medium-grained alluvium.
	haf	Fine-grained alluvium.
	hafs	Fine-grained salt-affected alluvium.
	hbm	Bay mud.
Pleistocene	*pa*	Late Pleistocene alluvium.

Map Symbols

———	Geologic contact.
—— 4 ——	Bay mud isopach; thickness in feet.
B ⌊___⌋ B'	Location of section (see Figs. 3 and 6).
━━━	Proposed levee alignment.
○	Existing boring.
●	Proposed boring.
×	Proposed test pit.

Notes

1) Topographic base from USGS 7.5′ Mipitas Quad.
2) Geology compiled from Bishop & Williams (1974), Helley & Brabb (1971) and Helley & Others (1979).

Earth Sciences Associates
Palo Alto, California

LOWER COYOTE CREEK PROJECT
GEOLOGY AND EXPLORATION MAP

Checked by ________ Date ______		Project No.	Figure No
Approved by ________ Date ______		D207P	1

The basic concept is to construct levees on either side of the existing Coyote Creek drainage using materials excavated from widening the creek bed. During normal years the water will flow in the widened channel, but during heavy rainfall periods, flood waters will be confined within the levee system. The Project crosses variable terrain that is divided into two reaches based on geography and geology.

Reach I lies within the lowlands and marshes adjacent to San Francisco Bay. Here the northern levee is to be built along the south side of the Newby Island land fill, where existing levees are inadequate. The southern levee in Reach I crosses a salt evaporating pond (Photograph 1), sludge ponds, and coastal marshlands (Photograph 2). This area is now drained by a slough while the active channel of Coyote Creek flows northward around Newby Island.

Levees in Reach II will be constructed in the active alluvial plain bordering Coyote Creek. The levees will cross farm lands (Photograph 3), flood plains, and sludge ponds (Photograph 4).

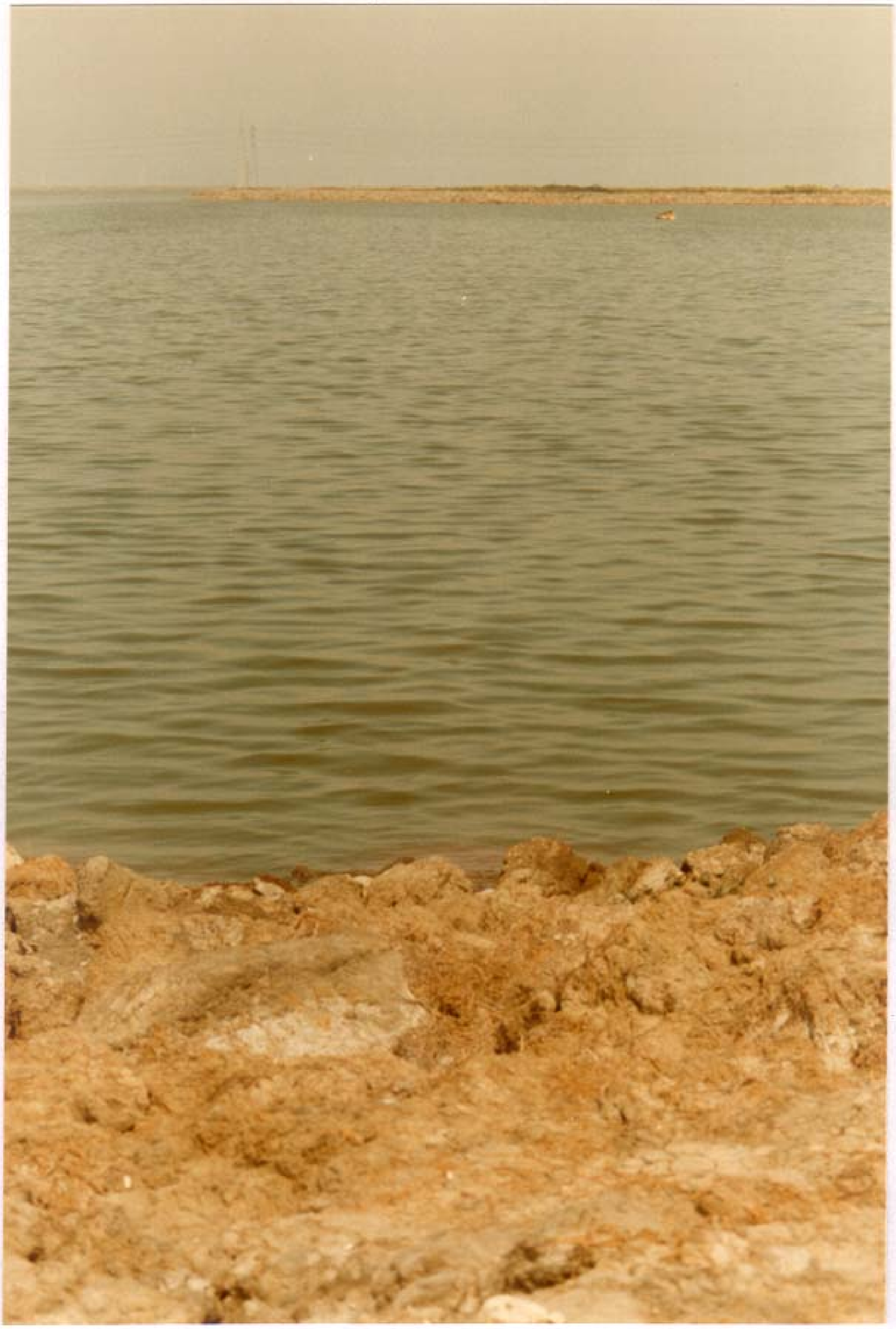


Photo 1. View west-northwest across salt evaporating pond in Reach I. The proposed levee runs from the bay mud dike in the foreground across the pond to the point on the dike in the distance. From there the levee veers to the right and terminates at another point on the evaporating pond dike.

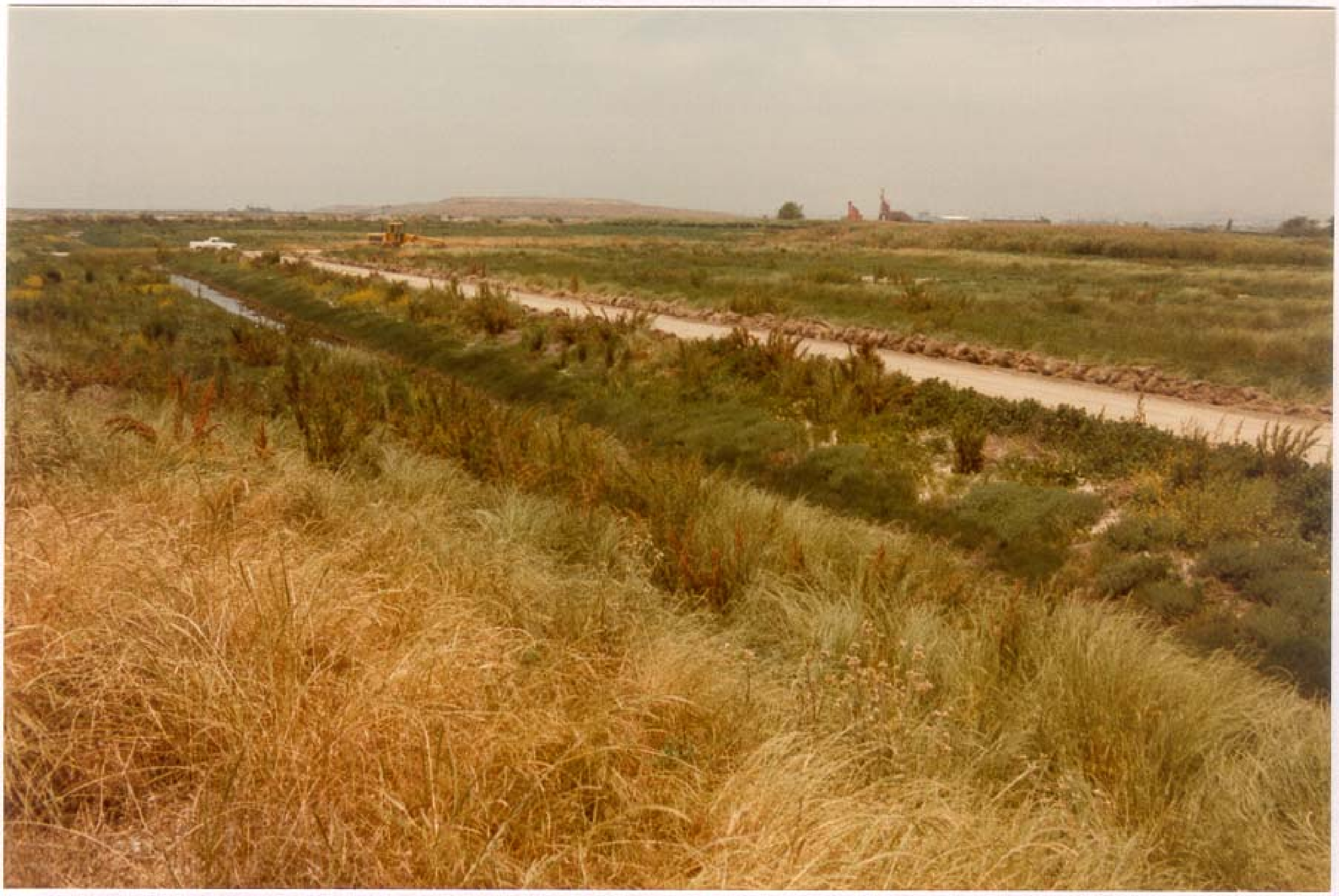


Photo 2. View northwest along the proposed levee alignment in Reach I. The levee traverses the marshy lands in the foreground that lie between the dikes for the sewage treatment ponds.

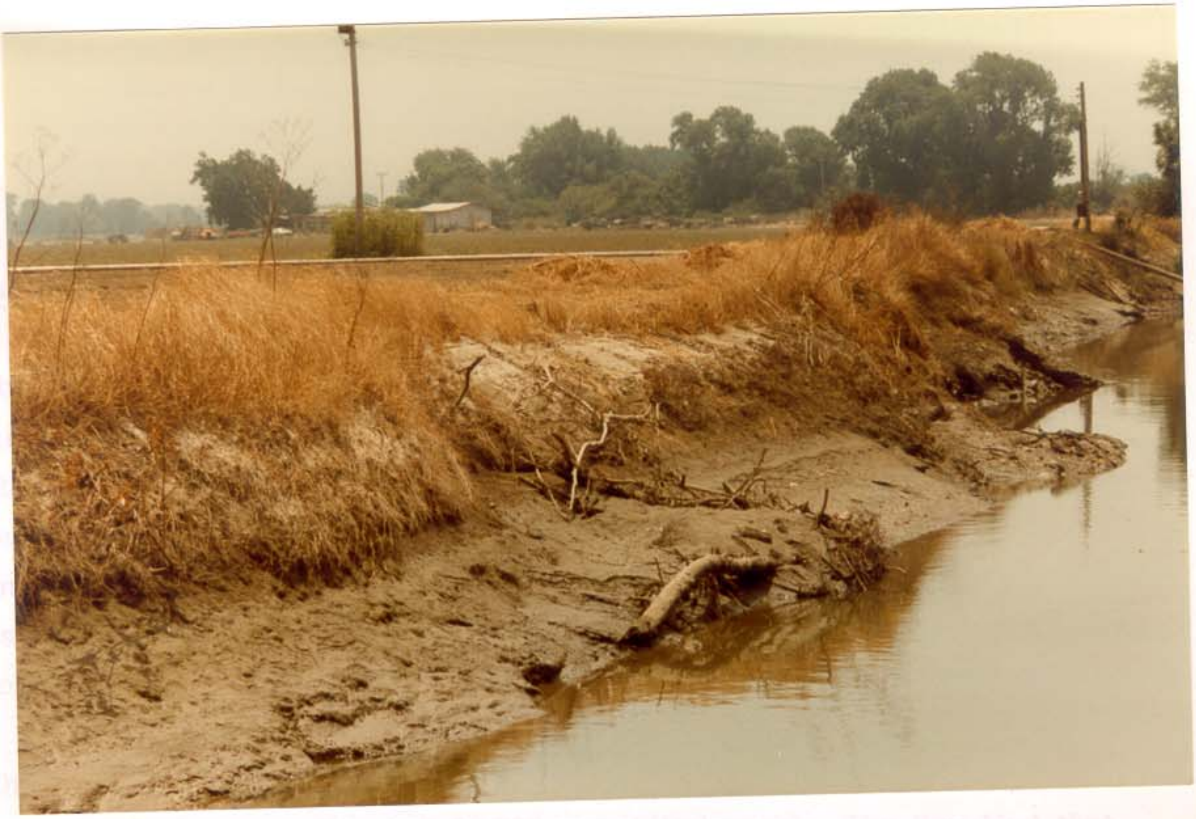


Photo 3. View south along eastern levee alignment in Reach II; Coyote Creek in foreground. The proposed levee crosses the farm land from the left of the photo to the right of the buildings in the background.

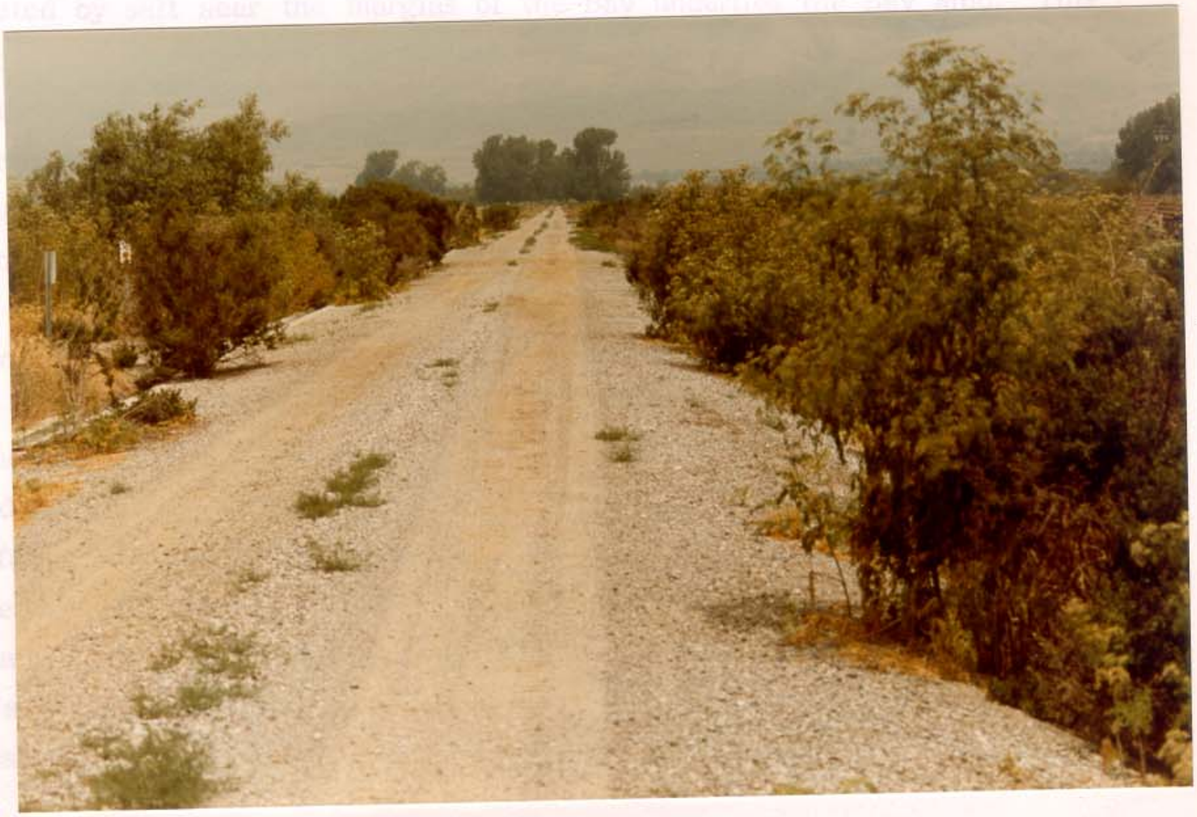


Photo 4. The proposed levee will be constructed as a raise along the east (right) side of this sewage treatment pond dike in Reach II.

II. PROJECT UNDERSTANDING

A. Geology

The Lower Coyote Creek Project area lies within a broad sedimentary basin filled with alluvial and estuarine deposits to depths of more then 500 feet. The site is located at the transition zone where alluvium interfingers with Bay Mud, as reflected by the outcrop pattern of geologic units shown in Figure 1. Much pertinent information exists on the geology and engineering properties of deposits in the area through the U.S. Geological Survey, the California Division of Mines and Geology, and unpublished consultants' reports.

The proposed levees will be constructed on presently forming deposits that have been developing over the past 10,000 years (Holocene). The Bay Mud that underlies Reach I was deposited in an abandoned course of Coyote Creek that formed when the sea level was lower than at present. It consists of unconsolidated, saturated, plastic silts and clays rich in organics. Fine-grained alluvium that may be affected by salt near the margins of the Bay underlies the Bay Mud. This formation includes unconsolidated, plastic silt and clay formed in seasonal fresh-water marshes. Medium-grained alluvium crops out in Reach II. These deposits are composed of unconsolidated fine-grained sand, silt, and clayey silt with occasional lenses and stringers of coarse-grained sand. At depth, but not directly affecting the foundation conditions for the project, are older and generally more coarse-grained alluvium that presently crop out further towards the base of the Diablo Range to the east.

The project area lies within a seismically active zone bounded by the Hayward fault to the east and the San Andreas fault to the west. Although no active faults have been mapped in the project area and no fault ground rupture hazard exists at the site, severe ground shaking will affect the site. This shaking could cause stream bank landslides, lateral spreading, ground settlement, ground cracks, sand boils, and associated liquefaction as has been documented during past earthquakes.

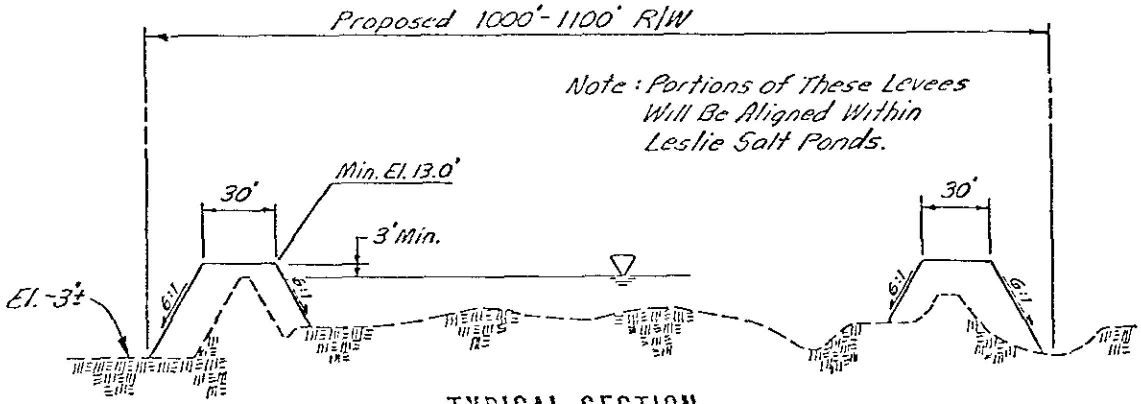
B. Reach I

The proposed levees in this reach will have a total length of approximately 17,000 feet and will have a geometry as shown in Figure 2.

The subsurface soils present along this reach consist primarily of Young Bay Mud deposits with a maximum thickness of about 16 feet. The Bay Mud is underlain by fine-grained alluvium (see Sections A-A, B-B and C-C of Figure 3). The Bay Mud that is exposed at low tide and also that which is submerged in the bay is in an unconsolidated, semi-fluid state and is largely derived from fine sediments deposited from local drainage waters. During the summer it dries out by evaporation and tends to consolidate by dessication. This has resulted in the formation of a 2 to 3 feet thick crust covering the soft Bay Mud. Because of its low shear strength and high compressibility, significant settlement will occur and lateral spreading of the mud (mud waves) may occur when a load, such as that produced by a fill or a levee, is placed upon it. This requires that special precautions be taken when designing and placing fills on these deposits.

The proposed levee alignment route in Reach I is in the east-west direction as shown in Figure 1. The thickness of the Young Bay Mud deposits increases from zero at the eastern end of the alignment to about 16 feet at the western end. The typical levee section proposed by the District within this reach will be 10 to 13 feet high, with a crest width of 30 feet and side slopes of 6 (h) to 1(v) or flatter.

The levées will generally be constructed using materials excavated from the immediate vicinity of the new levee or dredged from the bay. The section of the alignment running from the beginning of Reach I to the margin of the Bay will be constructed using materials obtained from various possible sources. The southern levee will probably be built using materials obtained from the sludge ponds after removal of the sludge deposits, materials from the existing sludge pond levee which will eventually have to be removed or breached, or materials excavated or dredged during widening of the new creek channel. The northern levee will probably be constructed with materials obtained from the latter source.



Note: Portions of These Levees Will Be Aligned Within Leslie Salt Ponds.

TYPICAL SECTION
REACH I

From SCVWD

Earth Sciences Associates
Palo Alto, California

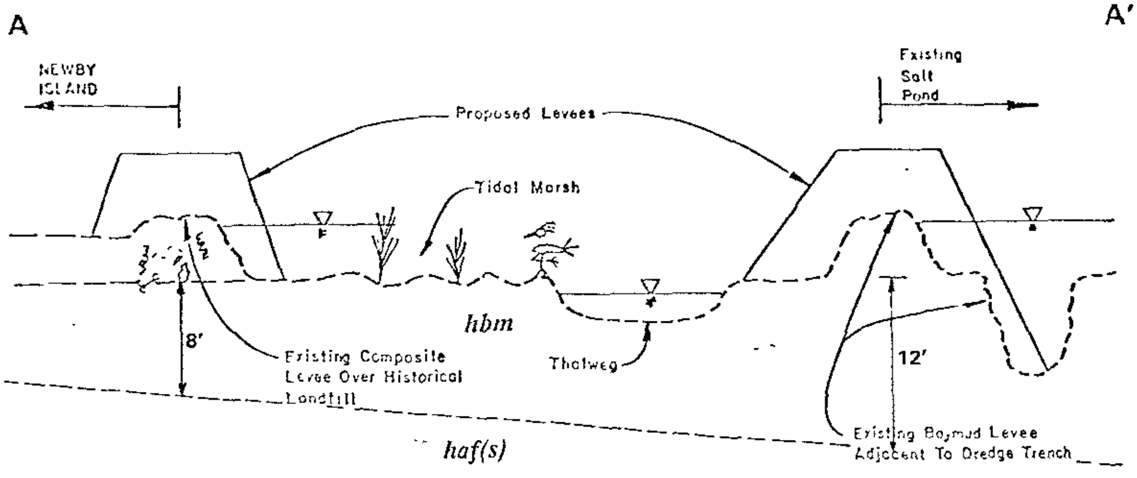
LOWER COYOTE CREEK PROJECT
PRELIMINARY TYPICAL SECTION

Checked by ______ Date ______	Approved by ______ Date ______	Project No. D207P	Figure No. 2

The levees within the existing salt pond and along the tidal marsh areas (Sections A-A' and B-B' of Figure 3) will be constructed by dredging operations. Representatives of the Leslie Salt Company, who are the owners of these ponds, have indicated that they would prefer not to drain or dike off portions of the pond while the levees are being built. This would make dredging the most suitable method for constructing the southern levees located in the salt pond. Dredging would be done within the portion of the salt pond closest to the existing shoreline. After completion of the southern levee in the salt pond, the dredge would then be relocated so that it can work its way along the tidal marsh area to construct the northern levee along this section of Reach I. Bay Mud dredged from the tidal marsh area would be placed upon the existing composite levee to form the new North Levee. Dredging would probably be carried out as far inland as possible.

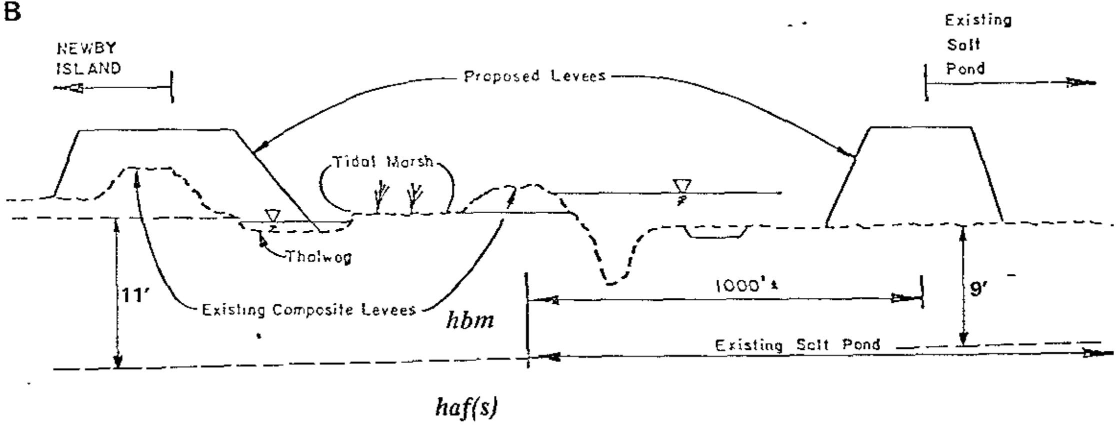
Because of the low shear strength of the underlying soft Bay Mud, mud waves are generally produced when fill is placed on these deposits. In order to reduce the creation of mud waves, careful placement of the dredged materials is important. The use of a hydraulic dredge, whereby the dredger fluid flows over large areas and the building up of sediments progresses more or less uniformly and slowly, represents one of the best methods to prevent the occurrence of mud waves. The continuous maintenance of flat slopes at the edge of the fill will also greatly reduce the size and creation of mud waves, provided, however, that the fill is not placed too rapidly and its final height is limited. The District has suggested slopes on the order of 6(h) to 1(v) for the slopes of the levees to be constructed over Bay Mud. Flatter slopes may be necessary to ensure that significant mud waves are not created and that the desired height of levee is attained. Since the rate of filling has a major effect on the creation of mud waves it would be advantageous if the desired height of levee could be attained by filling in stages. The actual rate of filling should be established on the basis of local experience and observations in the field during construction.

From observations, it has been established that some heaving beyond the fill periphery is inevitable; it is more pronounced in the case of fills with steep slopes than with gentle slopes. It is also more pronounced when fills have been placed by end-dumping rather than by hydraulic dredging.


A
A′
NEWBY ISLAND
Existing Salt Pond
Proposed Levees
Tidal Marsh
hbm
8′
Existing Composite Levee Over Historical Landfill
Thalweg
12′
Existing Baymud Levee Adjacent To Dredge Trench
haf(s)

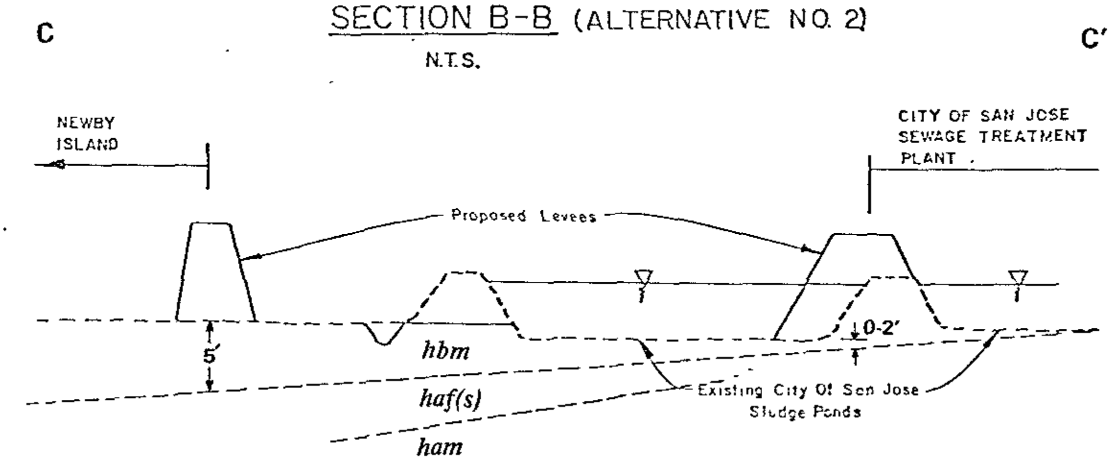
SECTION A-A (ALTERNATIVE NO. 1)

N.T.S.



SECTION B-B (ALTERNATIVE NO. 2)

N.T.S.


C
C′
NEWBY ISLAND
CITY OF SAN JOSE SEWAGE TREATMENT PLANT
Proposed Levees
5′
hbm
0-2′
haf(s)
Existing City Of San Jose Sludge Ponds
ham

SECTION C-C (ALTERNATIVE NO. 3)

N.T.S.

GEOLOGIC UNITS

hbm	Bay mud.
hafs	Fine-grained salt-affected alluvium.
ham	Medium-grained alluvium.

NOTES

1) See Figure 1 for location of sections.
2) Sections from Santa Clara Valley Water District RFP, May 31, 1983.

Earth Sciences Associates
Palo Alto, California

LOWER COYOTE CREEK PROJECT
GEOLOGIC CROSS SECTIONS A-A′, B-B′, & C-C′

		Project No.	Figure No.
Checked by ______	Date ______	D207P	3
Approved by ______	Date ______		

In some cases, instability can be caused by tidal fluctuations. At a certain stage of high tide, the slope of the bay mud fill is partially confined by the tidal water. At other stages during low tide, this confinement is removed. The fill slope and its underlying mud is therefore subjected to a continuous process of stress change, and the underlying mud may fail without any other external provocation.

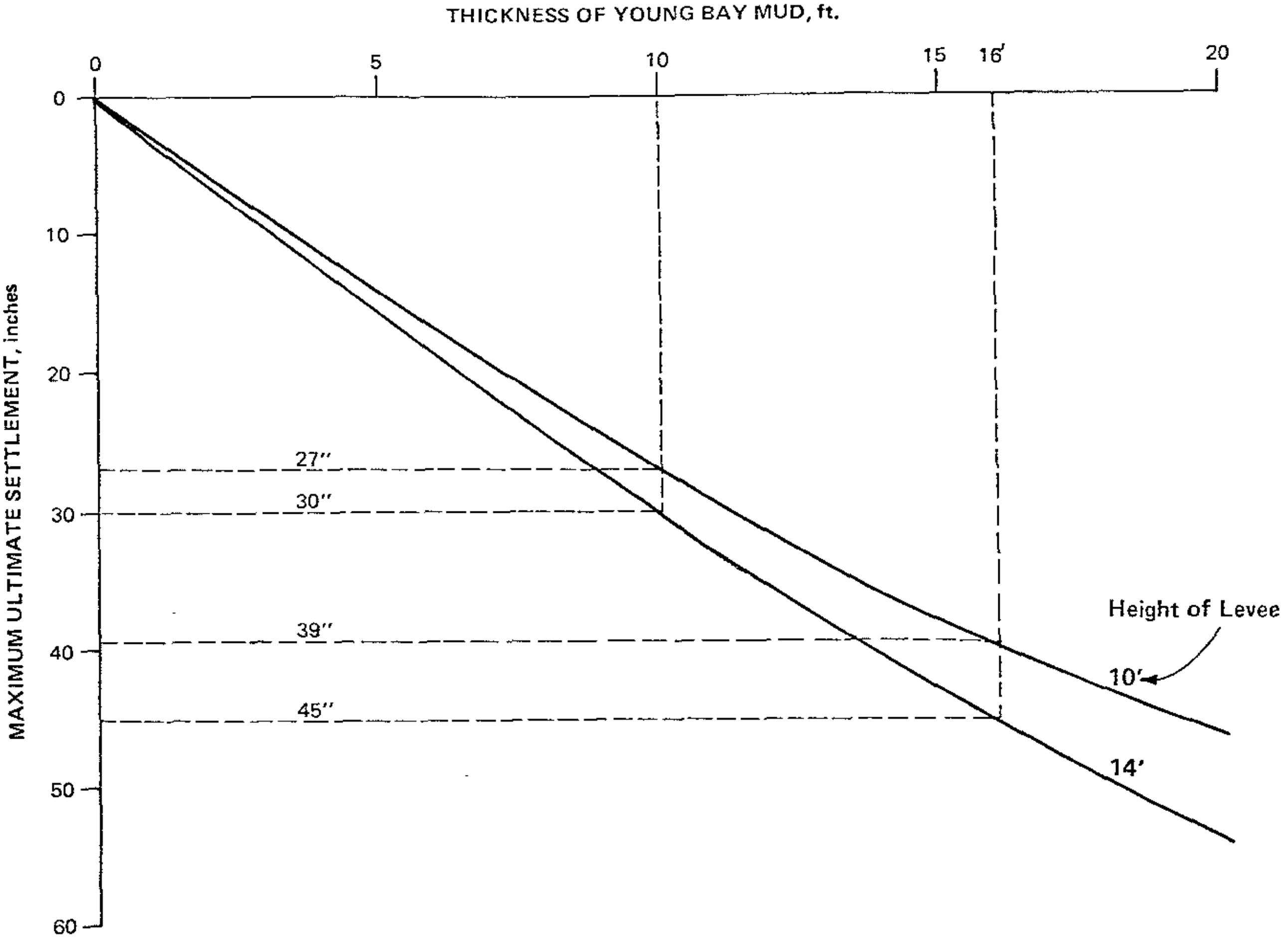
In addition to the creation of mud waves, significant settlement (consolidation) of both the underlying Bay mud and the fill itself will occur over a period of time. Based on Bay Mud data developed for studies carried out at Redwood Shores, we have calculated the magnitude of total settlement that would occur for levee heights of 10 and 14 feet and for various thickness of Bay Mud (assuming a 3 foot thick crust). These are shown in Figure 4. Maximum settlements on the order of 27 to 45 inches are obtained for depths of Bay Mud ranging from 10 to 16 feet. This does not include the consolidation of the dredged materials which comprise the levee itself. Thus, the levees will have to be constructed several feet higher to account for the settlement which will occur with time.

C. Reach II

The proposed levees in this reach will have a total length of approximately 18,000 feet and have a geometry as shown in Figure 5. The levees will be constructed using native materials which will be excavated from and adjacent to the present Coyote Creek channel.

Most of the levees along Reach II will be constructed within a 500 feet wide right-of-way along the Coyote Creek flood plain. About 1,200 feet of levee will cut across existing sludge ponds of the San Jose-Santa Clara Sewage Treatment plant facility along the extreme northwestern portion of this reach.

The foundation conditions present along this reach are generally represented by the geologic cross sections (D-D and E-E) shown in Figure 6. Based on a review of geotechnical reports available in the District's offices and other geologic and geotechnical reports and data pertinent to the proposed project area, the soils which directly underlie this reach are described as medium-grained alluvium (see Figure 1) which consist primarily of silty clay, silts, silty sands, fine sand and gravel. The granular materials vary from being very loose to medium dense.



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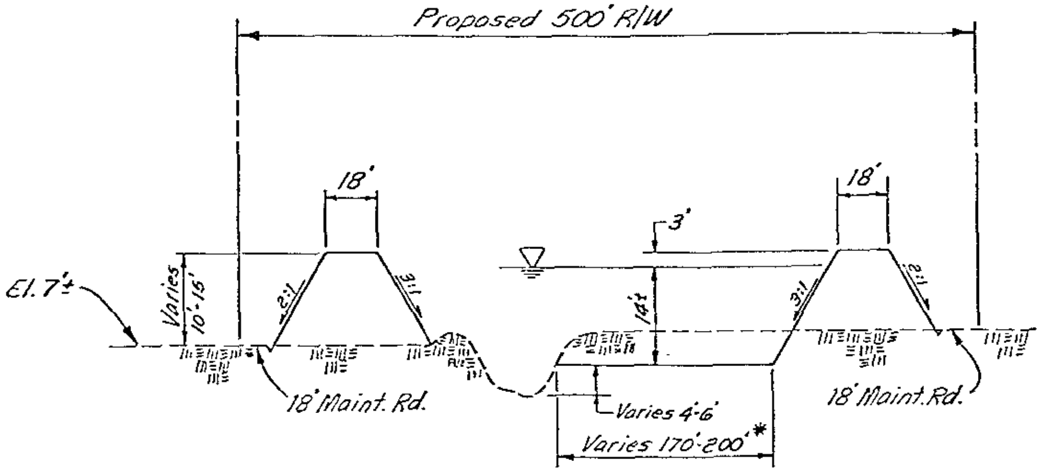
Palo Alto, California

LOWER COYOTE CREEK PROJECT

SETTLEMENT OF LEVEES ON YOUNG BAY MUD DEPOSITS

Checked by ______________ Date ______
Approved by ______________ Date ______

Project No.	Figure No.
D207P	4



TYPICAL SECTION
REACH II

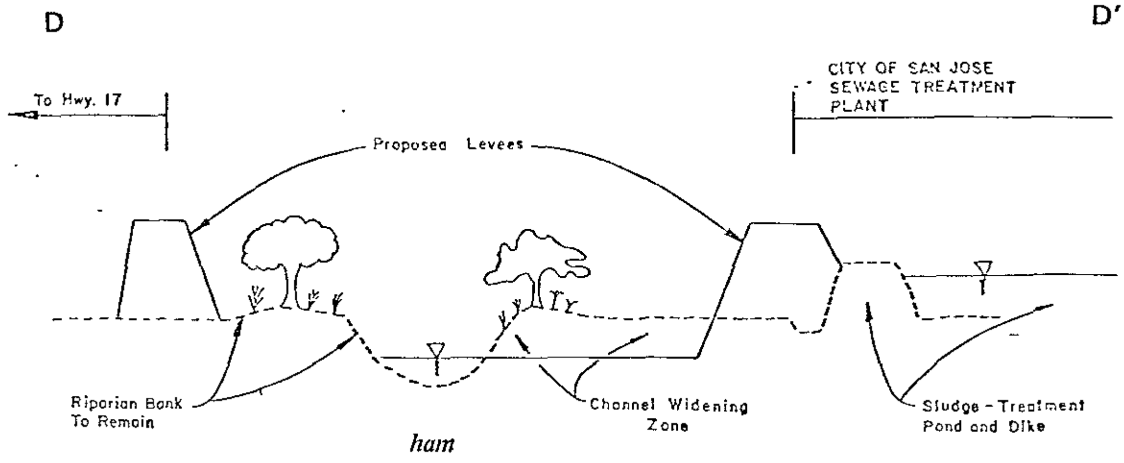
* "One Bank Widening" - May Vary From East To West Side of Channel.

Earth Sciences Associates
Palo Alto, California

LOWER COYOTE CREEK PROJECT
PRELIMINARY TYPICAL SECTION

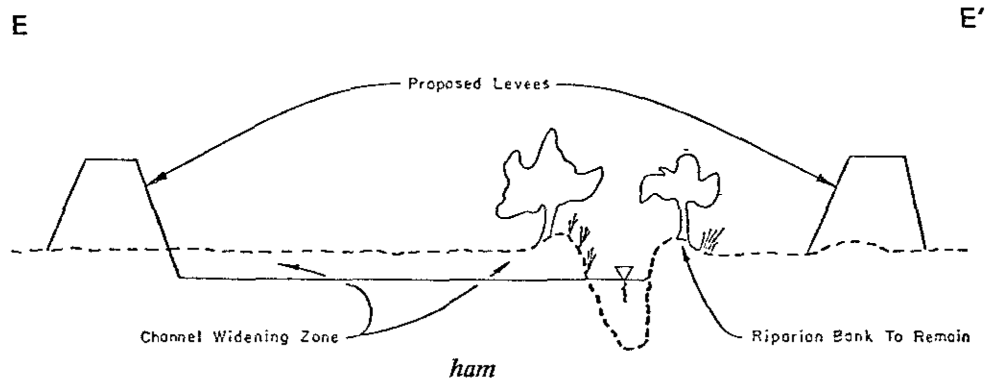
Checked by ____________ Date ______
Approved by ____________ Date ______

Project No. D207P
Figure No. 5



SECTION D-D (ALTERNATIVE NO. 4)

N.T.S.



SECTION E-E (ALTERNATIVE NO. 5)

N.T.S.

GEOLOGIC UNIT

ham Medium-grained alluvium.

NOTES

1) See Figure 1 for location of sections.
2) Sections from Santa Clara Valley Water District RFP, May 31, 1983.

Earth Sciences Associates
Palo Alto, California

LOWER COYOTE CREEK PROJECT
GEOLOGIC CROSS SECTIONS D-D' & E-E'

Checked by ______________ Date ______
Approved by ______________ Date ______
Project No. D207P
Figure No. 6

As was mentioned previously, the levees will be constructed using on-site native soils. These materials appear to be suitable for this purpose, however, they may be subject to erosion. This consideration will be further discussed later in this section.

The preliminary typical section of the levees in Reach II, as shown in Figure 5, suggest that at least one bank of Coyote Creek, which may vary from the east to the west side of the channel, will be widened by 170 to 200 feet. The depth of the widened channel will be about 2 to 7 feet below the present ground surface and approximately 4 to 6 feet above the bottom of the Coyote Creek Channel. Based on discussions with the District's staff, a similar type of construction is also proposed for flood control levees planned for the stretch of Coyote Creek located south of Highway 237 and north of Montegue Expressway. Although these levees are not part of this proposed project, it is of interest to note that preliminary quantity "take-off" estimates made by the District's staff indicate that approximately 100,000 to 200,000 cubic yards of material will remain in excess after construction of the levees in this reach and in Reach II. Rough quantity estimates made by ESA during the preparation of this proposal indicate that virtually all of the surplus material will come from the levee construction proposed for the stretch of Coyote Creek located south of Highway 237. The construction of the levees just in Reach II, however, may be "just" balanced or may be short by as much as 70,000 cubic yards depending on how much the creek channel is widened and deepened within the reach. If after more detailed quantity calculations are made and it is determined that sufficient quantities of construction materials do not exist within Reach II, additional borrow sources will have to be identified or the possibility of using the surplus materials from the areas south of Highway 237 could be evaluated.

Groundwater along the southern portion of Reach II has been encountered at a depth of about 12 to 14 feet below the ground surface in boreholes drilled in the orchards adjacent to Coyote Creek and Highway 237. The depth to groundwater becomes shallower in the northern portion of the reach as the topography drops to the Bay. Other data compiled by the California Division of Mines and Geology (CDMG) indicate similar depths to groundwater. It is probable that groundwater levels vary throughout the year and from year to year and may be influenced by the amounts of water flowing in the Coyote Creek channel. Groundwater levels within this reach are an important consideration in that they determine the depth of material that can be removed from the Coyote Creek channel by earth-moving equipment during channel widening without extensive dewatering.

It is our understanding that the construction sequence along most of this reach would consist of the following steps:

1. The areas that will be used as borrow sources or upon which embankments will be placed will be stripped of all vegetation or undesirable materials. Topsoil would be stockpiled for later use.

2. The materials in and adjacent to the Coyote Creek channel will be excavated by earth-moving equipment and placed and compacted to construct the levees.

3. Topsoil would be placed and planted along both the upstream and downstream faces of the levees if it is determined during the course of the investigation that this would provide adequate erosion protection.

As was previously mentioned, the soils present along this reach are generally granular in nature and are relatively erodible. Since the purpose of the levees is to provide flood protection to adjacent areas during the 100-year design flood, it is probable that the proposed levees would rarely be subjected to the levels of flows that would cause significant erosion. In addition, if the existing Coyote Creek channel is improved by widening and/or deepening, the velocities of normal flows could be reduced to levels that would minimize erosion. Therefore, based on these considerations, erosion protection of the proposed levees might not be a major consideration over much of this reach and only minimal protection of the structures might be required.

Based on a preliminary review of the available geotechnical data, no unique geotechnical problems exist along most of this reach. Special consideration will have to be given to the portion of the levee that will cut across and lie adjacent to the existing sewage treatment ponds of the San Jose-Santa Clara Sewage Treatment Plant. At the present time, it appears that the only concern along this segment is to schedule construction so as to limit disruption of the existing treatment plant facility.

D. Seismic Design Considerations

Because the entire San Francisco Bay area is located within a region subject to a high level of seismic activity, consideration must be given to the seismic hazards that could affect the proposed study area. Damage to proposed levees can result from several types of earthquake-related activities:

a. Rupturing of the ground surface along a fault line either as a sudden break during an earthquake or as the result of slow creep not necessarily accompanied by an earthquake.

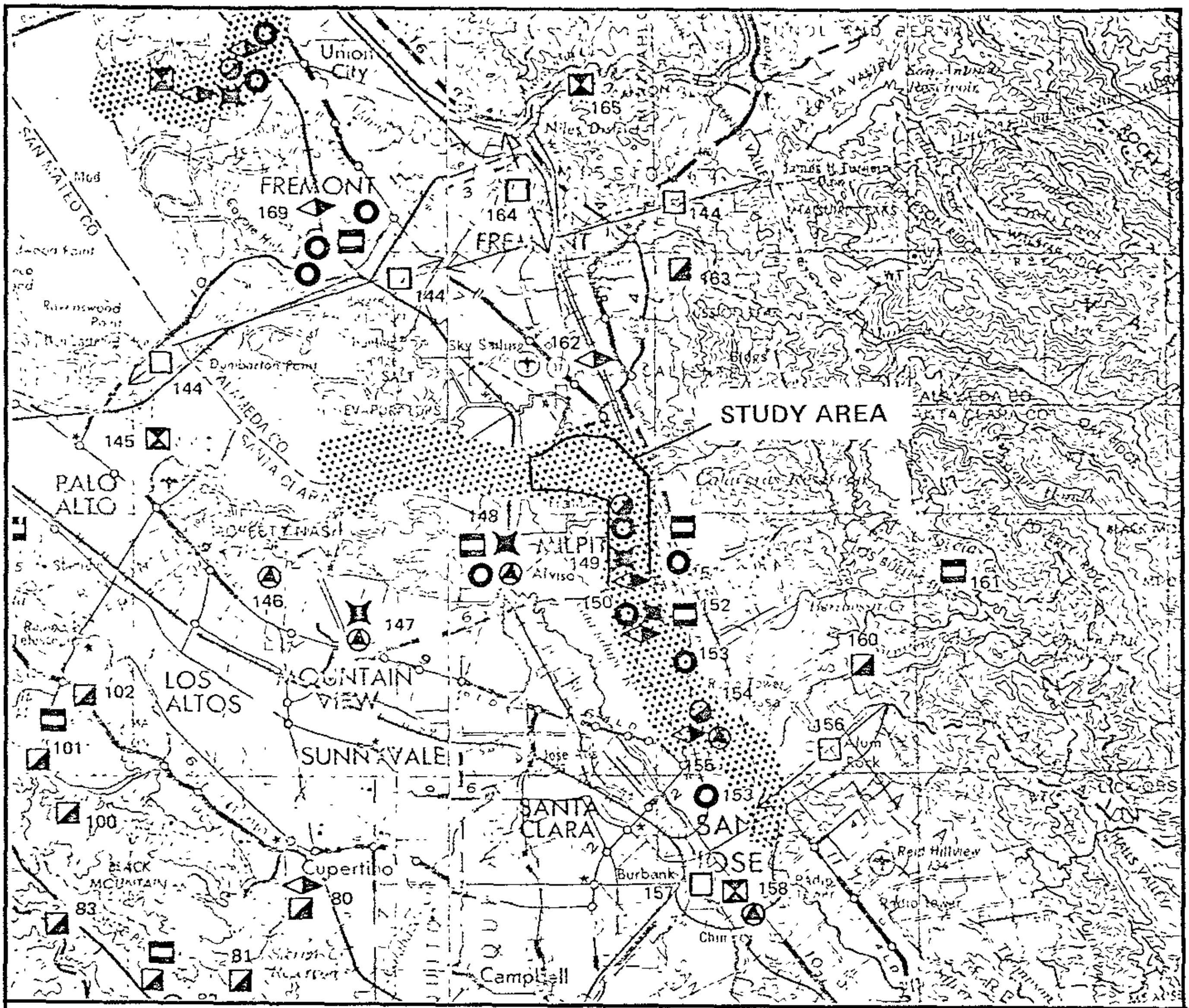
b. Seismic shaking.

c. Secondary ground failures resulting from shaking and vibrations accompanying an earthquake.

No faults are known to traverse the study area, however, severe ground shaking and secondary ground failures are likely to occur in the study area as a result of a large magnitude earthquake produced by any one of the several nearby faults.

Failure of the ground during earthquake shaking may result from the liquefaction of loose, saturated, granular soils, the sudden loss of strength in sensitive clays, the sliding of marginally stable slopes, or differential settlements resulting from the sudden compaction of soft, normally consolidated soils. Records indicate that the project study area has experienced seismically-induced ground failure in the past, particularly from the 1906 San Francisco earthquake. Youd and Hoose (1978) have found historic references to stream bank landslides, lateral spreading, ground settlement, ground cracks, extensive fissuring and sand boils in the flood plain of Coyote Creek. Locations of ground failures in the project area resulting from the San Francisco earthquake of 1906 are shown in Figure 7. The damage that occurred along the portion of Coyote Creek located within the study area during the 1906 earthquake is included in Table 1.

ESA is particularly well qualified to evaluate the various seismic hazards that are present within the study area. During the past several years, ESA has



EXPLANATION

Failure type is indicated by the following symbols. Quotations describing these ground failures are found in Table 2.

◪	**Hillside landslides including rotational slumps, block glides, debris avalanches, and rockfalls.**
◐	**Streambank landslides including rotational slumps and soil falls.**
◁▶	**Lateral spread**
⊠	**Ground settlement**
▭	**Ground cracks not clearly associated with landslides, lateral spreads, settlement, or primary fault movements**
░	**River stretches with extensively fissured flood** ***plains; pattern indicates stretches of river*** **affected and not width of distrubed zone**
◯	**Sand boils**
Ⓐ	**Disturbed wells**
□	**Absence of ground failure noted**
⧗	**Miscellaneous effects**
<□>	**Arrows showing extent of area affected, Symbol shows failure type**
110	**Location number assigned to each reported ground failure site. Descriptions of effects in immediate site area found in Table 2**

0 5 10
miles

FROM: Youd & Hoose, 1978

Earth Sciences Associates
Palo Alto, California

LOWER COYOTE CREEK PROJECT
LOCATION MAP OF GROUND FAILURES
IN THE STUDY AREA

Checked by ________ Date ______		Project No.	Figure No.
Approved by ________ Date ______		D207P	7

TABLE 1.—*Specific descriptions of ground failures in the San Francisco Bay counties region*

San Francisco Bay, Santa Clara Valley, and east bay hills--

Location No.	Figure No.	Failure type	Accuracy	Year of earthquake	Reference	Quotation
148		◁▶	C	1906	*Salinas Daily Index*, 1906b.	On Alviso slough two rows of trees in an orchard had parted off and slid into the slough.
		Ⓐ ✦ ○	C	1906	Taber, 1906, p. 315; also *in* Jordan, 1907, p. 279.	A well near Alviso, at the head of the bay, formerly required a wind-mill to pump the water. At the time of the earthquake the casing was driven 2 feet out of the ground, wrecking the pump, and since that time the well has been flowing under a heavy pressure. In some of the lowlands small cracks were formed, out of which water issued, bringing up mud and sand.
		✦	C	1906	Ransome, 1906, p. 294.	[Railroad grade subsidence of several feet] is reported from Alviso, a town at the south end of San Francisco Bay.
149		◁▶ ◔ ○ ◁▶	A	1906	Weatherbe, 1906, p. 402.	* * * some rather remarkable demonstrations of the earthquake have occurred along the levee paths following the Coyote river north from the bridge on the road from Milpitas to Alviso. * * * At the locality mentioned large fissures, as much as eight feet wide and of nearly equal depth, have been opened and as partial filling ensued immediately, they must have been of much greater depth when first formed. In some places the road has been completely precipitated into the creek and at a point about half a mile below the bridge both the banks and the bed of the stream, including a heavy growth of willows, have been cut by a series of parallel cracks and the trees and banks thrown into the stream, thus forming a partial dam. All of these cracks are roughly parallel with the stream * * *. Simultaneously with the above phenomena, dozens of small geysers or spouting craters were formed along the creek and in the adjacent fields. The mouths of these varied in diameter from three inches to about 15 in., though the actual orifices probably do not exceed four or five inches in diameter. Mud and water were spouted to a height of over twenty feet, and continued to flow for several days. On some of the miniature craters incrustations of salt were deposited. The bridge above-mentioned was shifted on its concrete supports, the two ends moving in opposite directions, and throughout the same locality rows of trees in the orchards are said to have been twisted and staggered out of shape.
150		◁▶ ✦ ○	B	1906	Lawson and others, 1908, p. 281.	At Mrs. North Whitcomb's ranch, on the south side of the Alviso-Milpitas road, between Coyote Creek and Milpitas, the prune orchard was cracked and the ground shifted at several places. The ranch-house, of concrete with a wooden upper story, was cracked across the northwest corner and settled slightly on the northwest side. In the back yard were fissures 1 foot wide, running about N. 13° W., with a downthrow of 1 foot on the east side. Some of the prune trees in the orchard are 2 feet out of alignment, and some as much as 6 feet. The lateral displacement here shows a relative movement of the south side toward the east. Considerable sand was brought up by water flowing from the cracks in this orchard.

Reference: Geological Survey Professional Paper 993.

conducted many similar investigations at other project sites which include dams and earth embankments located within the State of California. These projects have required use of both detailed finite element analyses as well as other accepted simplified analysis techniques. The valuable experience gained by ESA personnel during these past projects will also be useful in estimating the amount of damage that might occur as the result of earthquakes of various magnitude and in developing measures to help mitigate the hazards which are present at the site.

III. TECHNICAL APPROACH

General

Based on our current understanding of the project, we propose that a three phased approach be followed. Our general approach outlined below is similar to the one presented to you in our Statement of Qualifications for this project and is directed at obtaining the geotechnical information needed to successfully complete this project in a timely and economical manner.

A. Phase I - Review Available Data

Phase I will include a complete review of all the existing reports and data available on the proposed project and/or study area. The review would include geotechnical investigations performed for other large projects built in the project vicinity and/or situated on similar site conditions.

As part of our preparation of this proposal and our statement of qualifications we have reviewed many of the available reports and are aware of the significant amount of information that is currently available for this project. It should be noted that significant amounts of valuable information on the character, strength and behavior of the types of soils that underlie much of the project site are also available in published literature. Much of the geologic and hydrologic reports that are available for the study area have been reviewed for the preparation of this proposal and were used in establishing the generalized subsurface profiles presented in Figures 3 and 6.

A preliminary field and laboratory investigation plan has been developed based on our preliminary review of the available data. A more in-depth review of the data may define other areas where more detailed information is required in order to provide a basis for the design of a safe and economical flood control levee system. Prior to the start of the field and laboratory testing program, the program will be submitted to the District for their review and comments.

B. Phase II - Field Investigation, Laboratory Testing Program, and Preliminary Analyses

There have been approximately 20 boreholes drilled along the two reaches of the proposed levee alignment and/or in the immediate vicinity of the project site during the course of previous investigations (see Figure 1 for borehole locations). Other recent data are also available for the surrounding area such as for the San Jose-Santa Clara Sewage Treatment Plant and for the bridges over Coyote Creek at Highway 237. Based on our preliminary review of the available data, we propose the following field investigation:

1. A total of six, shallow hollow stem auger boreholes (up to 30 feet deep) will be drilled at the locations shown in Figure 1. Three borings will be drilled along each of the reaches. These borehole locations were selected on the basis of accessibility, as verified by our field reconnaissance of the project area, and are intended to "fill-in-the-gaps" in the existing data. Relatively undisturbed Shelby tube and Standard Penetration Test samples of the soils would be obtained for subsequent laboratory testing. Piezometers consisting of slotted PVC casing would be installed in the three holes located along Reach II in order to monitor near surface groundwater levels prior to and during construction. As was previously discussed in the section "Project Understanding", groundwater levels, in this Reach, are an important factor in determining the volume of excavatable construction materials available.

2. Four test pits will be excavated along Reach II at the locations shown in Figure 1. These will be used to evaluate the extent and character of the near-surface soils, as well as to determine their suitability for use as borrow sources. In addition to detailed logging of the test pits, in situ testing of the materials will be performed, which may include density tests, torvane and pocket penetrometer tests. Bulk samples of representative materials will be obtained for subsequent laboratory testing.

If a more detailed evaluation of the volume of excavatable materials determines that other borrow sources need to be identified, additional borings and/or test pits may be necessary. If required, we will establish a field program and will submit it to the District for their review and comments.

Based on our present knowledge of the project and of the existing site conditions, we do not feel that more extensive subsurface exploration such as geophysical exploration, drilling of rotary boreholes or Dutch Cone penetration tests will be required. However, if a more detailed review of the existing data and the project design indicates that these types of exploration will provide useful data, they will be included as part of the field exploration program.

Laboratory tests will be performed on representative disturbed and undisturbed soil samples obtained from the field investigation. We believe the following types of tests will probably be required on both bulk and undisturbed Shelby tube samples obtained from the test pits, and exploratory boreholes:

- Compaction tests.
- Sieve and hydrometer analyses.
- Atterberg limits.
- Consolidation tests.
- Unconsolidated "Quick" static triaxial tests.
- Consolidated undrained tests with pore pressure measurements.

As was previously mentioned, a significant amount of geotechnical data exists on the types of materials present along the proposed levee alignment. These data are available in the preliminary geotechnical reports performed for this project as well as in the published literature. Therefore, at the present time, we expect that only a limited number of laboratory tests will be required to supplement the existing data. The actual number of the tests that will be performed will be determined during Phase I and the program will be submitted to the District for their review and comments.

Concurrently with the field and laboratory investigation, preliminary evaluations of all the data will be made as they become available. Preliminary analyses and evaluations will be performed to establish the following:

- Stability of the levee slopes under static, earthquake and post-earthquake loading conditions.
- Foundation characteristics.
- Settlement of the levees along the various reaches.
- Availability and suitability of on-site materials for levee construction.
- Extent and type of slope protection.
- Groundwater conditions.
- Methods of construction and development of remedial measures that may be required to mitigate potential hazards or construction difficulties.

As was previously noted in the section "*Project Understanding*", the study area has been subject to earthquake-induced ground failures during (or after) past earthquakes. It is our judgment that ground failures of the foundation soils similar to those that occurred during the great 1906 San Francisco Earthquake will probably reoccur during an earthquake of similar magnitude. While it might not be feasible (nor economical) to develop levee designs to mitigate all the potential hazards posed by poor ground behavior during an earthquake similar to the 1906 event, it is possible to estimate the levels of damage that would occur during an event of this size as well as the damage that would occur during other earthquakes which have a higher probability of occurrence.

For this investigation, we propose to estimate the levels of damage that might occur along the two reaches of the levels as the result of earthquakes of various magnitudes. The earthquake stability analyses of the levees and underlying foundations will consist of the following steps:

1. Determine probable earthquake levels - The 50 and 100 year events on faults that could produce significant ground shaking at the site would be estimated. The earthquakes would be based on CDMG guidelines and our experience in the area.

   Recurrence relationships developed by ESA during previous investigations in the Bay area would be utilized in addition to published relationships.

2. Levels of ground surface accelerations would be evaluated for the probable events. Published attenuation relationships would be utilized for this purpose.

3. The liquefaction potential of the subsurface soils would be determined on the basis of SPT blow count data and the gradational characteristics of the soil. A simplified rigid body analysis would be utilized as proposed be Seed (1983). The level of ground surface acceleration causing liquefaction of the foundation soils would be determined and compared with the levels of acceleration that could be caused by the Probable earthquake determined in Steps 1 and 2. If the "Probable" earthquakes can produce acceleration levels high enough to produce high pore pressures or cause liquefaction of the foundation soils, then estimates of the damage to the levees would be made as described in Step 4.

4. The damage caused by "Probable" earthquake ground motions along Reach I would be estimated using a cumulative deformation procedure as outlined by Newmark (1965) and further developed by Makdisi and Seed (1978). This analysis procedure would probably be appropriate along this reach since the foundation soils are Bay Mud and the strength of these soils during cyclic loading are fairly well known.

   The behavior of the levees along Reach II would be more difficult to determine if liquefaction of the foundation soils is likely to occur during "Probable" earthquake ground shaking. Damage to the levees under this condition could be extensive (i.e., similar to the 1906 earthquake).

If the "Probable" earthquake motions do not cause complete liquefaction of the foundation soils, then the potential damage caused by ground shaking can be estimated by using the Makdisi and Seed approach. The strength of the foundation soils would be estimated by using the effective strengths of the foundation soils along with the buildup of pore water pressure expected to occur during ground shaking. Pore water pressures would be based on empirical relationships recently proposed by Seed and are based on SPT blow count measurements.

The level of deformations expected to occur during different levels of earthquake ground shaking would then be summarized in graphical form.

As was previously discussed in the section on "Project Understanding", the construction of fills on Bay Mud must be closely controlled so that the displacement of the soft foundation materials by the fill is minimized. This can be done by controlling the rate at which the fill is placed, by the use of geotextiles to improve the bearing capacity of the subsurface soils and by improving subsurface drainage. We will evaluate the various alternatives available as part of this study and will help develop a reasonable, effective, economical, construction program that will result in a good levee system. Construction sequencing will also be an important consideration in the construction of the levees through the existing salt ponds and sewage sludge ponds. Some procedures to construct these sections were discussed in our "Project Understanding". We will work closely with the District and other concerned parties to establish the best method of construction in order to limit the disruption of existing operations.

C. Phase III - Finalize Analyses and Report Preparation

Phase III would consist of the following tasks:

- Summarize all the findings and results of the field and laboratory investigations.
- Finalize all analyses, recommendations and design criteria for the proposed project.

- Submit a draft report to the District for review. The report will present all the findings and data obtained during the course of this and previous investigations.

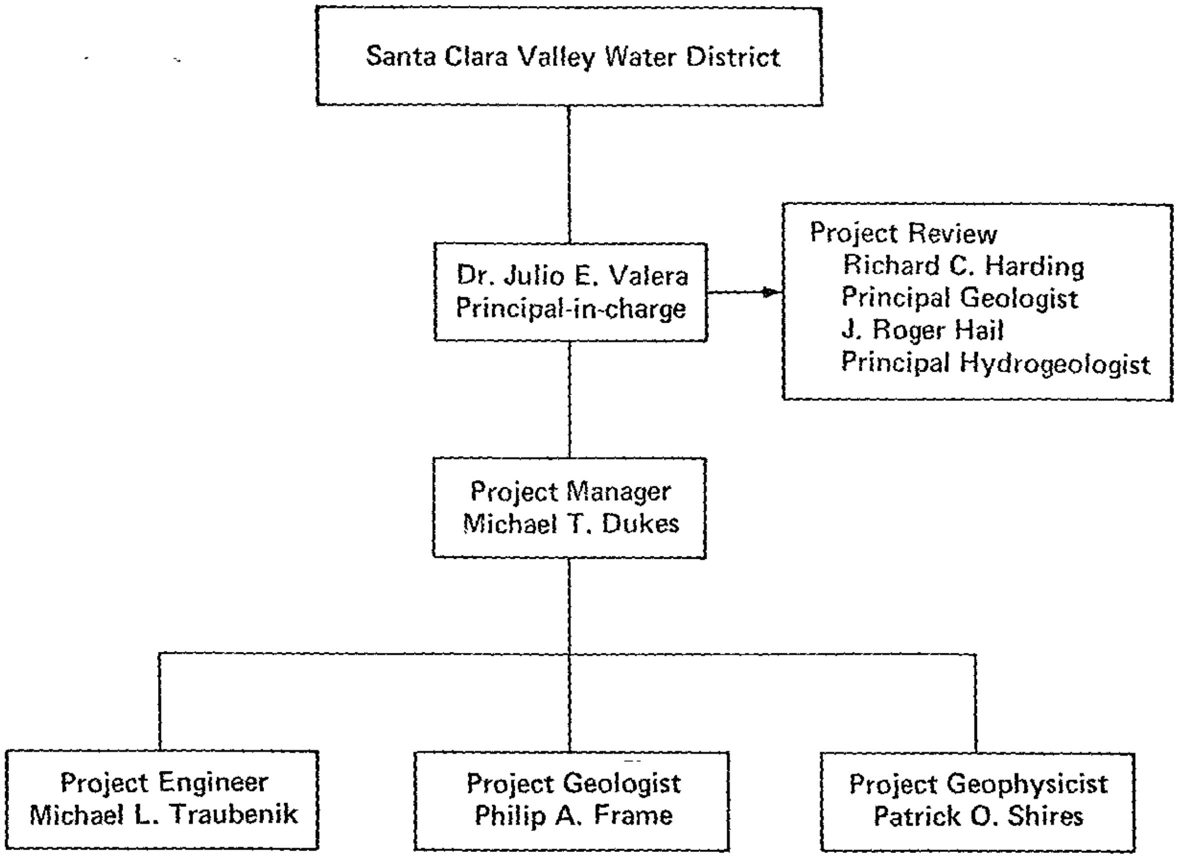
- Submit a final report which incorporates the District's comments.

Meetings will be held with the District to discuss progress and findings of each phase of work outlined above.

IV. PROJECT MANAGEMENT AND SCHEDULE

The project organization team showing the key personnel who will perform the proposed study is shown in Figure 8. Resumes of these personnel were included in our Statement of Qualifications submitted earlier; they will be supported as required throughout the project by well qualified staff engineers and geologists.

A preliminary work schedule is presented in Figure 9. We understand that the current schedule anticipated by the District for the subject geotechnical study calls for work to begin in July, and for a final report to be completed by about the end of October. We will be able to complete the study within this time frame of about 14 weeks. To ensure that preliminary findings of the study are made available to the District's staff, we propose having regular meetings during the course of the work.



Earth Sciences Associates
Palo Alto, California

LOWER COYOTE CREEK PROJECT
PROJECT ORGANIZATION CHART

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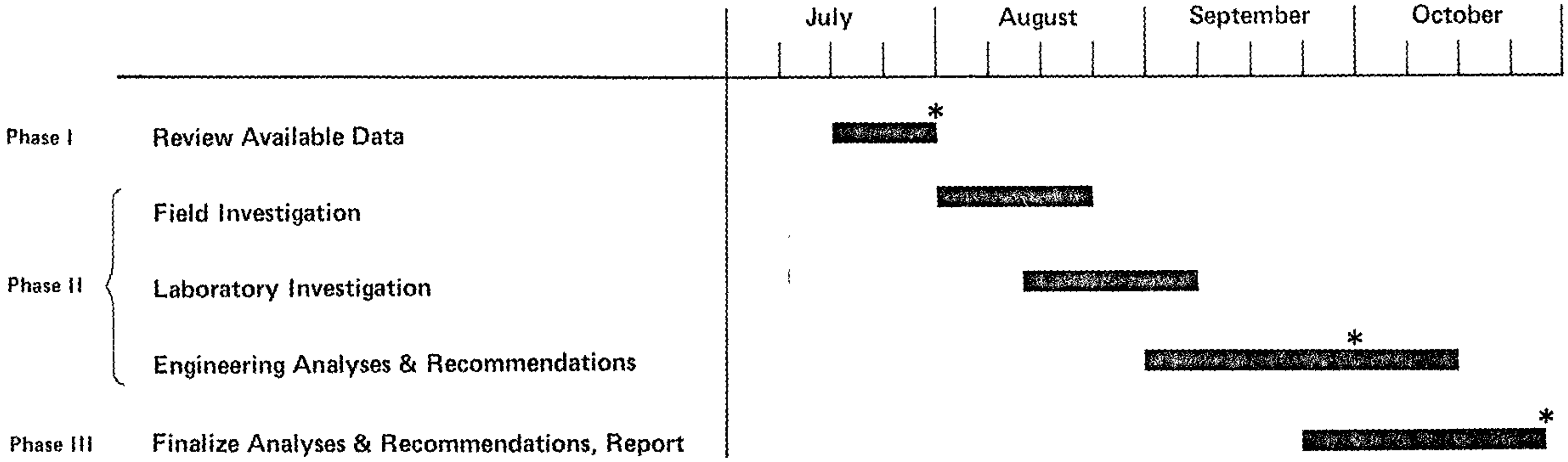
Approved by ______ Date ______

Project No.
D207P



*Meeting with District Staff

Earth Sciences Associates
Palo Alto, California

LOWER COYOTE CREEK PROJECT
PRELIMIMARY PROJECT SCHEDULE

Checked by ____________	Date ______	Project No.	Figure No
Approved by ____________	Date ______	D207P	9